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TUNA

in New Zealand Waters

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- Finding
- Identifying
- Catching
- Handling

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Tuna in New Zealand Waters

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Introduction

NEW ZEALAND has a great number of small vessels suitable for exploiting tuna, and the development of a fishery here must depend initially on the knowledge of distribution and abundance of the different species gained by local fishermen.

Besides describing tuna species this booklet deals briefly with different methods for catching tuna and explains the gear and layout for trolling (a fairly inexpensive method) and techniques for finding surface tuna schools. Methods of handling the catch on the vessels are also discussed, because tuna can deteriorate rapidly and become unsuitable for canning for human consumption.

Tunas are oceanic fish and the world oceans are exploited by long-liners, particularly from Japan, Taiwan, and South Korea and by purse seiners from the U.S.A. Since 1954 Japanese long-liners have regularly taken mainly southern bluefin and albacore off the New Zealand coast. During summer juvenile albacore, skipjack, southern bluefin, and yellowfin move into our coastal waters to feed on numerous schools of anchovy and squid and other prey. Once in shallow waters the tuna become vulnerable to surface fisheries such as trolling, gill-netting, pole and live-bait fishing, and purse seining.

The effectiveness of trolling as a technique is well illustrated by the development of the New Plymouth fishery. In 1970 one trolling vessel landed 10 tons of albacore. In 1972, 51 vessels varying in length from over 45 ft to less than 25 ft landed a total of over 100 tons.

The 1972 season lasted from January to early April, and during this period average catch rates ranged from 1,100 lb per day for the large vessels to 365 lb per day for the small ones.

Identification and Fishing Areas

THERE are about nine species of tuna and tuna-like fish in New Zealand waters. Four are likely to be commonly available in coastal waters to local vessels. The two most plentiful species — albacore and skipjack — are readily taken by trolling and pole and live-bait fishing and will probably continue to make up the bulk of the New Zealand catch. Two other species — southern bluefin and yellowfin — are occasionally found in large numbers, but will probably continue to make up only a small percentage of the annual catch.

All tunas (Fig. 1) have:

- A plump, stream-lined body; the first dorsal fin fits into a slot and the pectoral and pelvic fins fit into grooves.
- A series of finlets extending from the second dorsal and anal fins to the tail (or caudal fin).
- One pair of large fleshy lateral tail keels.
- Small or minute scales (except the butterfly tuna, which has large scales).

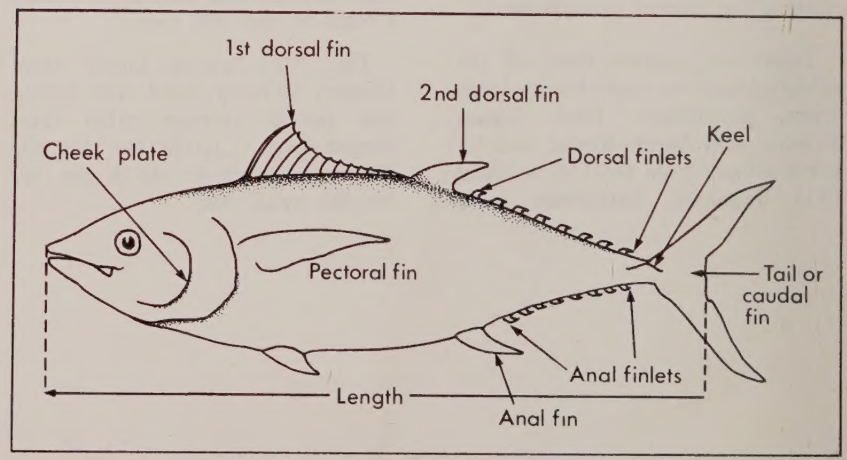


Fig. 1: A typical tuna.

Albacore *(Thunnus alalunga)*

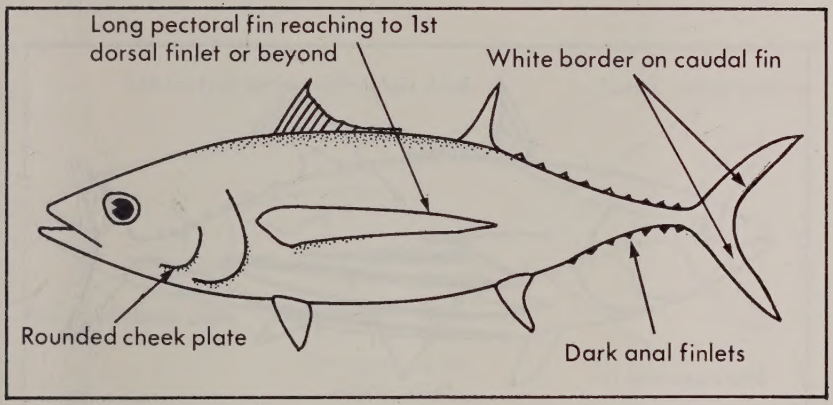

Long pectoral fin reaching to 1st dorsal finlet or beyond
White border on caudal fin
Rounded cheek plate
Dark anal finlets

Fig. 2: Albacore tuna.

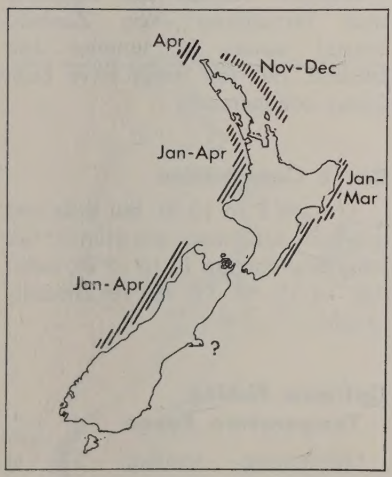


Fig. 3: Albacore fishing grounds.

Fishing Grounds

In spring usually outside 100-fathom line; in summer usually in shallower waters.

Catch Composition

East coast, North Island, and south-west coast, South Island: Mainly 4 to 25 lb, average 13 to 14 lb.

West coast (Manukau to Cape Foulwind): Mainly 4 to 14 lb, average 9 to 10 lb.

Fishermen have found surface schools of fish averaging 18 to 20 lb further off shore.

Optimum Fishing Temperature Range

East coast, North Island, and west coast, South Island: 17.5 to 20° C.

Manukau-New Plymouth: 19 to 22° C.

Skipjack *(Katsuwonus pelamis)*

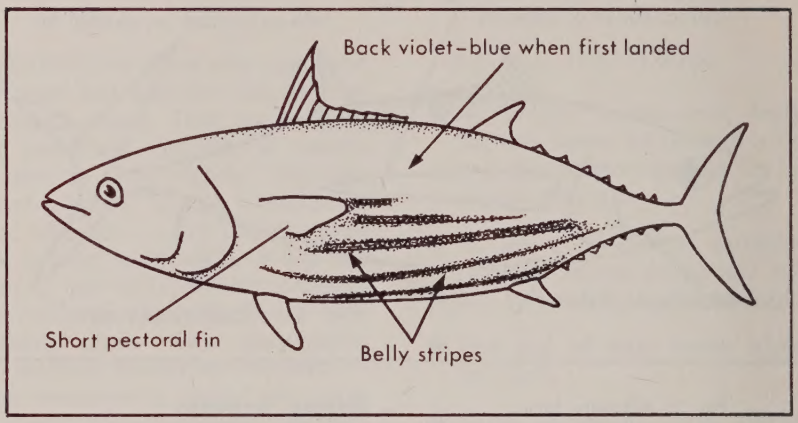


Fig. 4: Skipjack tuna.

Fig. 5: Skipjack fishing grounds.

Fishing Grounds

Skipjack schools are regularly seen throughout New Zealand coastal waters in summer and autumn, but few areas have been fished commercially.

Catch Composition

Average 8 to 10 lb, but pole and live-bait fishermen sometimes fish schools averaging 14 to 16 lb; small fish of 1 to $1\frac{1}{2}$ lb occasionally caught.

Optimum Fishing Temperature Range

Gill-netting, trolling: 17 to 21.5° C.

Pole fishing: 18.5 to 22° C.

Southern Bluefin *(Thunnus maccoyi)*

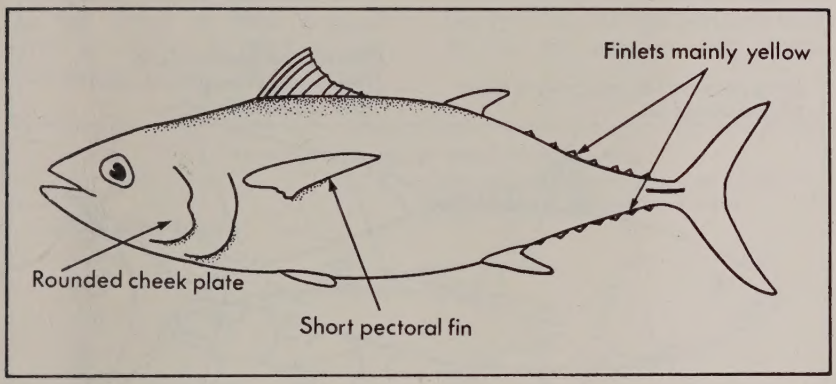


Fig. 6: Southern bluefin tuna.

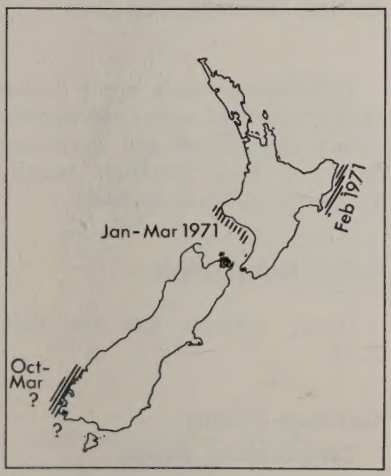


Fig. 7: Southern bluefin fishing grounds.

Fishing Grounds

Southern bluefin are sometimes found during summer in near-shore coastal waters. Their occurrence is sporadic and not well documented.

Catch Composition

Consists mainly of fish 20 to 30 lb. Larger fish averaging 50 lb have been caught off Fiordland.

Optimum Fishing Temperature Range

Trolling (New Plymouth): 20 to 22.8° C.

Pole fishing (North Island): 18 to 19.5° C.

Yellowfin (*Thunnus albacares*)

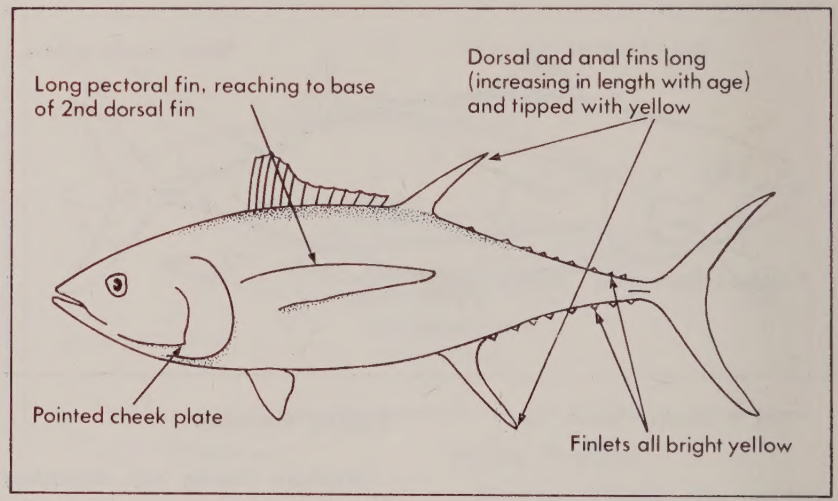

Long pectoral fin, reaching to base of 2nd dorsal fin
Dorsal and anal fins long (increasing in length with age) and tipped with yellow
Pointed cheek plate
Finlets all bright yellow

Fig. 8: Yellowfin tuna.

Fig. 9: Yellowfin fishing grounds.

Fishing Grounds

Yellowfin regularly occur during summer in small schools in warmer coastal waters off the north-east coast of New Zealand, usually within the 100-fathom line.

Catch Composition

Mostly juvenile fish less than 30 lb.

Optimum Fishing Temperature Range

All methods (very limited data): 19 to 22° C.

Other Species of Tuna

The distinguishing features of the five other species of tuna and tuna-like fish found in New Zealand waters are shown in the following illustrations. Only the English mackerel (Fig. 10) is abundant. The butterfly (Fig. 11), slender (Fig. 12), big-eye (Fig. 13), and northern blue-fin (Fig. 14) tunas are rarely caught.

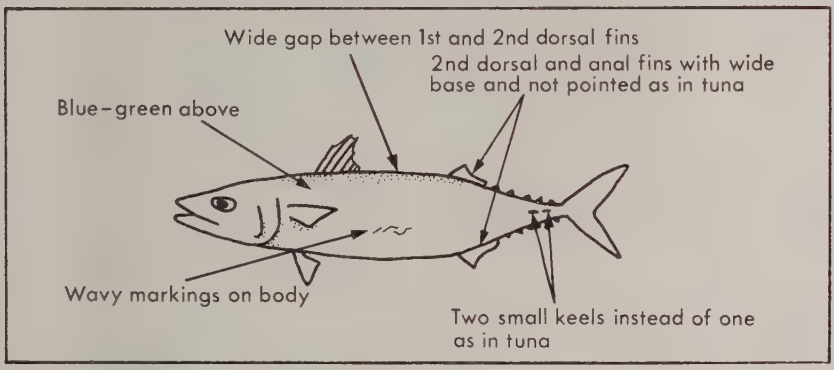

Wide gap between 1st and 2nd dorsal fins
2nd dorsal and anal fins with wide base and not pointed as in tuna
Blue–green above
Wavy markings on body
Two small keels instead of one as in tuna

Fig. 10: English mackerel.

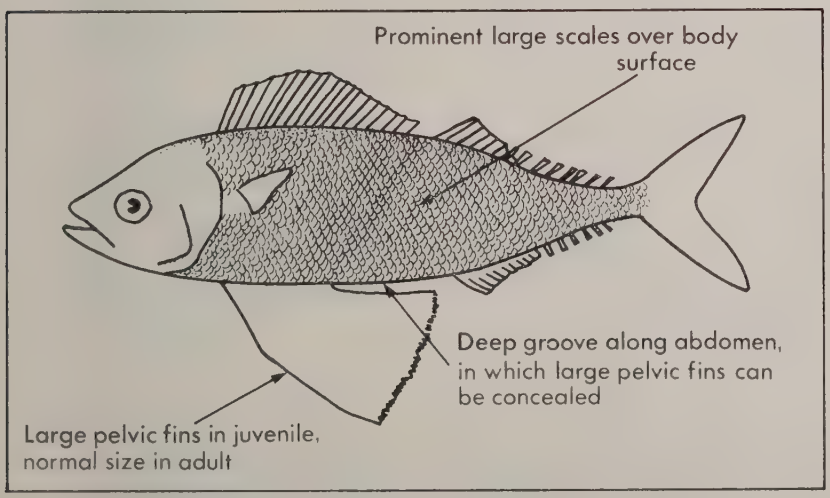

Prominent large scales over body surface
Deep groove along abdomen, in which large pelvic fins can be concealed
Large pelvic fins in juvenile, normal size in adult

Fig. 11: Butterfly tuna.

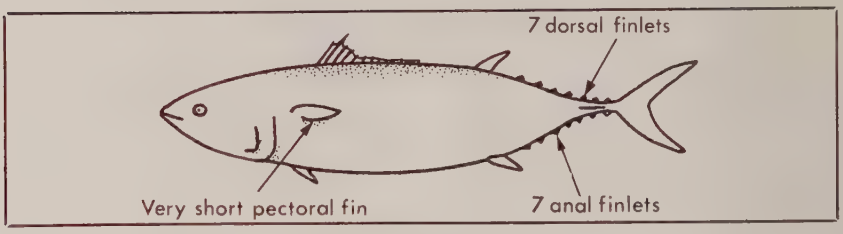


Fig. 12: Slender tuna.

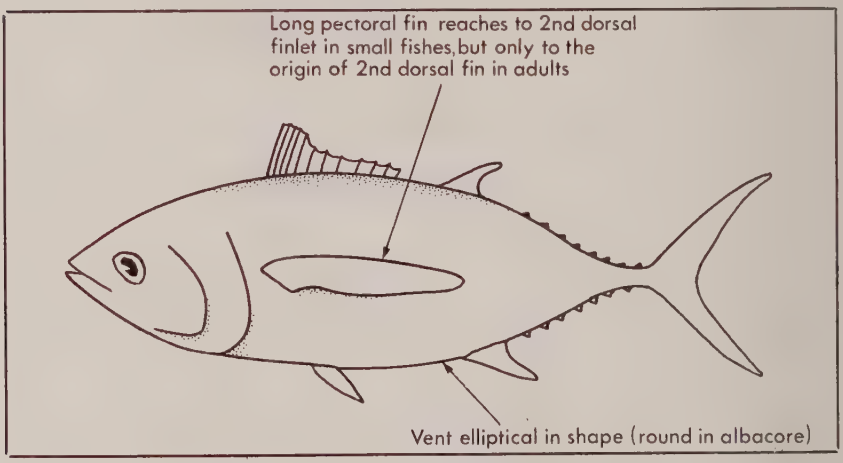

Long pectoral fin reaches to 2nd dorsal finlet in small fishes, but only to the origin of 2nd dorsal fin in adults
Vent elliptical in shape (round in albacore)

Fig. 13: Big-eye tuna.

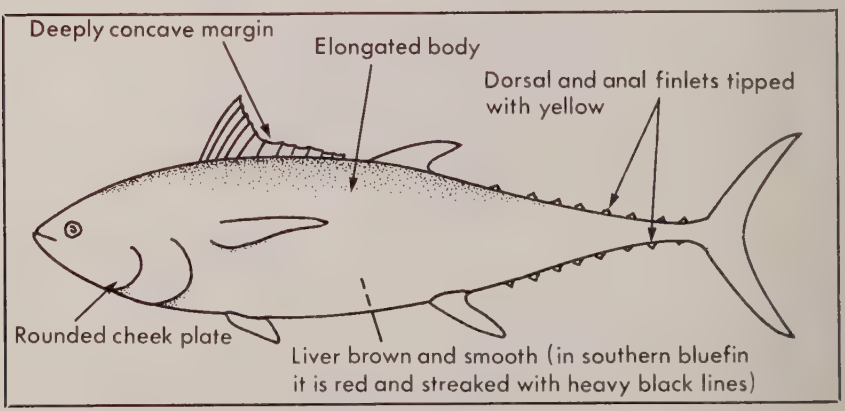

Deeply concave margin
Elongated body
Dorsal and anal finlets tipped with yellow
Rounded cheek plate
Liver brown and smooth (in southern bluefin it is red and streaked with heavy black lines)

Fig. 14: Northern bluefin tuna.

Methods of Tuna Fishing

Trolling (Mainly for Albacore)

TROLLING is by far the simplest method of catching tuna and involves only towing a number of lines, called trolling lines, behind the boat. An artificial lure or jig is used to attract fish to the hook. Tuna can be more readily attracted to the boat by "chumming" (throwing overboard bait-fish, usually anchovies or other small fish regurgitated by landed tuna).

Pole and Live-bait Fishing (All Species)

Pole and live-bait fishing is a more difficult and costly operation needing time and experience not only in tuna fishing but in finding and catching suitable bait. Experienced fishermen from both Japan and the United States of America working in New Zealand have demonstrated that this method is at least partially successful. It consists mainly of keeping a school of tuna close to the ship by chumming. The crew fishes with short lines on stout bamboo poles. Success depends on regular supplies of good-quality bait-fish.

Small vessels (less than 30 ft long) have used this method successfully in the Bay of Plenty. The live bait is held in modified 44-gallon drums. Such vessels can fish only in good weather and when tuna come close to the home port.

Purse Seine Fishing (Skipjack and Yellowfin)

Tuna schools are encircled with a huge wide-meshed net 380 to 450 fathoms long and 40 fathoms deep. This is the most costly method of tuna fishing, but in suitable conditions large quantities of tuna can be caught quickly.

Gill-netting (Skipjack)

Tuna usually occur in clear blue water, but sometimes skipjack enter discoloured water near the mouths of rivers, where they can be taken successfully with gill-nets.

There is some difficulty in unmeshing fish, and as tuna are not usually found in conditions suitable for gill-netting, this method has a limited application.

Long-lining (All Species Except Skipjack)

A long-line is a drifting line carrying hundreds of hooks hanging in mid water at depths of 30 to 100 or more fathoms. The main line can be 40 to 50 miles long and is buoyed at intervals. The hooks are baited with frozen or salted fish or frozen squid. The yield is low and the success depends on higher prices for the tuna and a ready market for other species caught.

Recent reports from tropical areas indicate that vertical long-lines are more efficient than the usual horizontal long-lines. Vertical long-lines have not yet been extensively tested in New Zealand waters.

Trolling Gear and Rigs

TROLLING can be carried out by vessels of any size, though it is not profitable for ships larger than about 55 ft in overall length. Each vessel is fitted with a pair of outriggers, the size of which varies with the length of the ship, and trolling lines are attached to the poles, as well as the stern, to give a greater coverage of the fishing area (Figs. 15 to 17). The poles are mounted forward on hinges at the base of the mainmast, on the ship's rail, or on the side of the cabin and are stayed fore and aft as well as above and below. The poles can be held in the upright position when not in use and lowered on a pulley to an angle of about 35° from the base line when they are used for fishing.

Rigs suitable for small vessels (up to 35 ft long) and larger vessels (35 to 45 ft and over 45 ft) are shown in Figs. 15 to 17. In 1971 and 1972 these rigs were used by vessels 20 to 50 ft long fishing out of New Plymouth. Though the rigs can be used as shown, some fishermen make minor modifications to suit their vessels once they have become familiar with the basic trolling technique.

As the trolling rig is very compact, it can be carried at all times. A vessel equipped for another type of fishing can transfer to trolling within a few minutes as the opportunity arises.

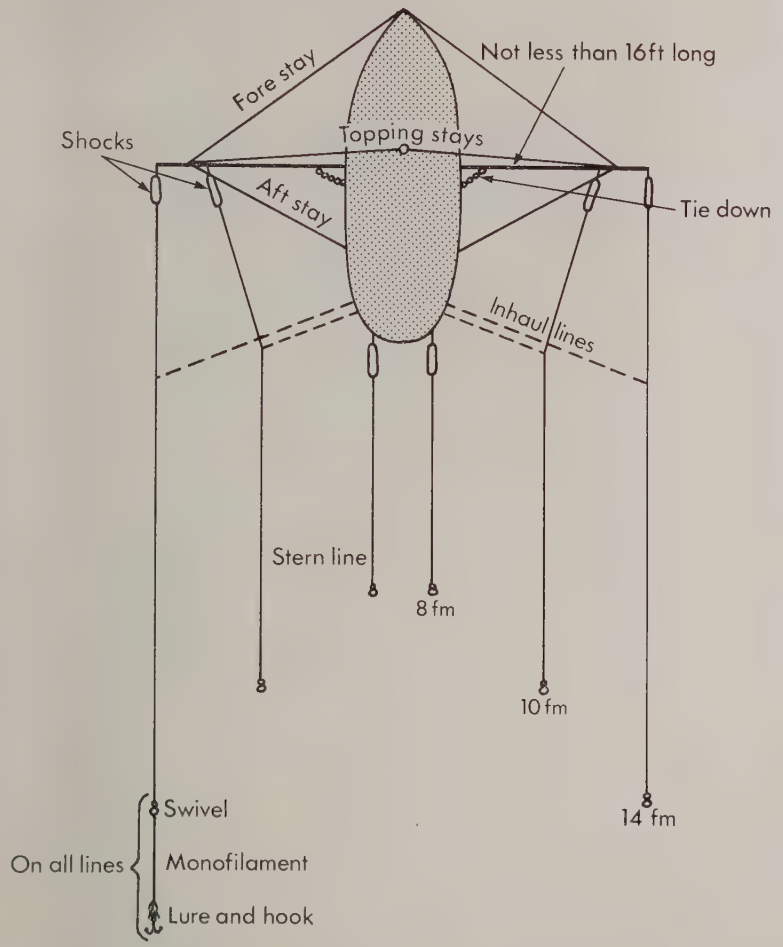
Tuna fishing by any method is basically a visual fishery, and care must be taken to relieve eye strain. Dark glasses and a cap with a good peak are needed. Circular rubber bands (grippers) cut from motorcycle inner tubes and worn on the fingers and palms will protect the hands, especially when hauling large fish with the monofilament trace.

Fishing Gear

The **shock** (Fig. 18) is a short length of rubber or other elastic material to take the shock as the fish strikes the lure. Sewerage pipe rings are excellent for this purpose, either left as a ring or cut and extended. A **safety loop** is required if a single strip of rubber is used. This prevents the gear being lost if the shock breaks. The safety loop should always have plenty of slack and should be about three times the length of the shock.

The **tag line** (Fig. 18) is of hard lay rope $\frac{1}{2}$ or $\frac{5}{8}$ in. in circumference or of plastic-coated steel wire. The latter offers less resistance to wind and the lines are then less likely to be blown about. The length of the tag line is adjusted so that when the inhaul line (7/16 in. braided terylene) is pulled in, the two-pole swivel can be clipped over a hook on the gunwale.

The **main line** (Fig. 18) is of braided terylene 7/16 in. in circumference and of about 350 lb



- No lead weights necessary.
- 2 in. or 3 in. diameter poles recommended.
- Whisky line not used if no tall mast.
- Tag lines should be attached to keep tension on inhaul lines and allow adjustments of main lines to fish in the wake.
- During heavy fishing longer lines can be shortened to reduce the distance the fish has to be pulled.

Fig. 15: Trolling rig for vessels up to 35 ft long.

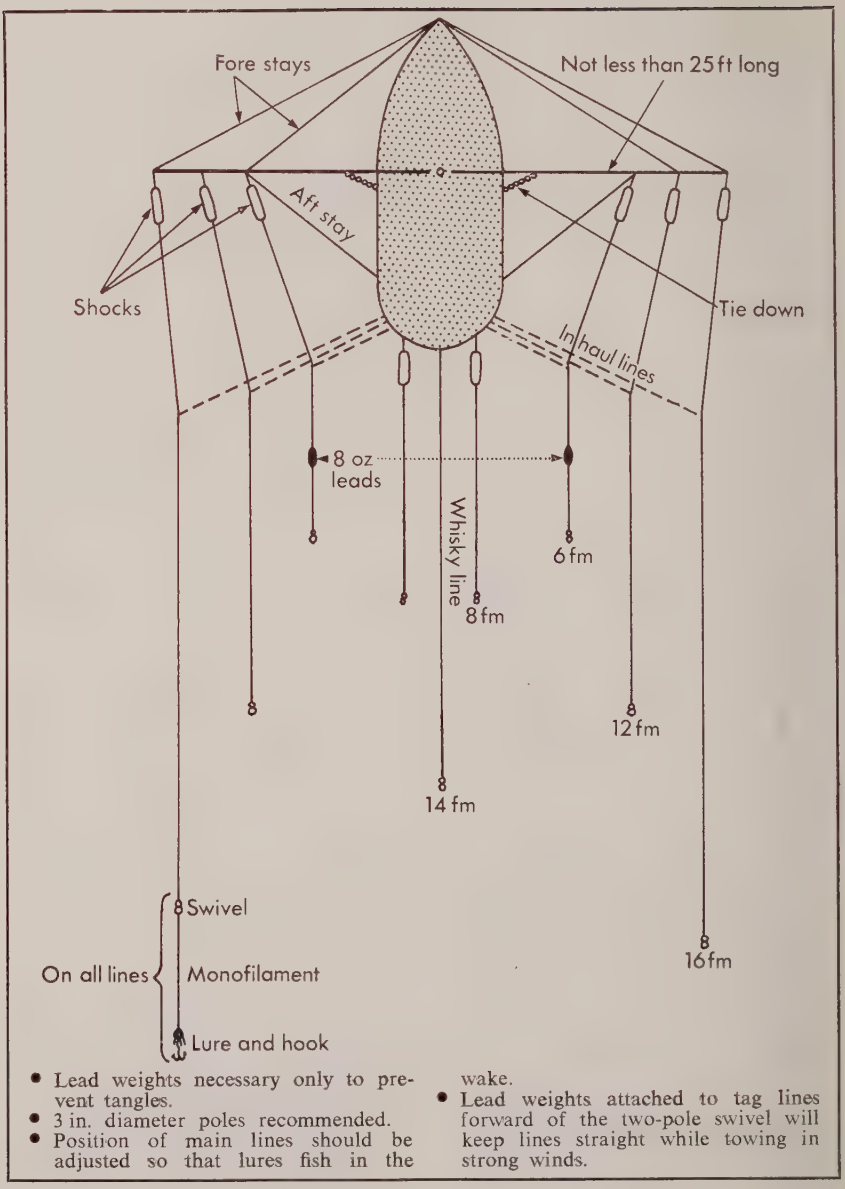
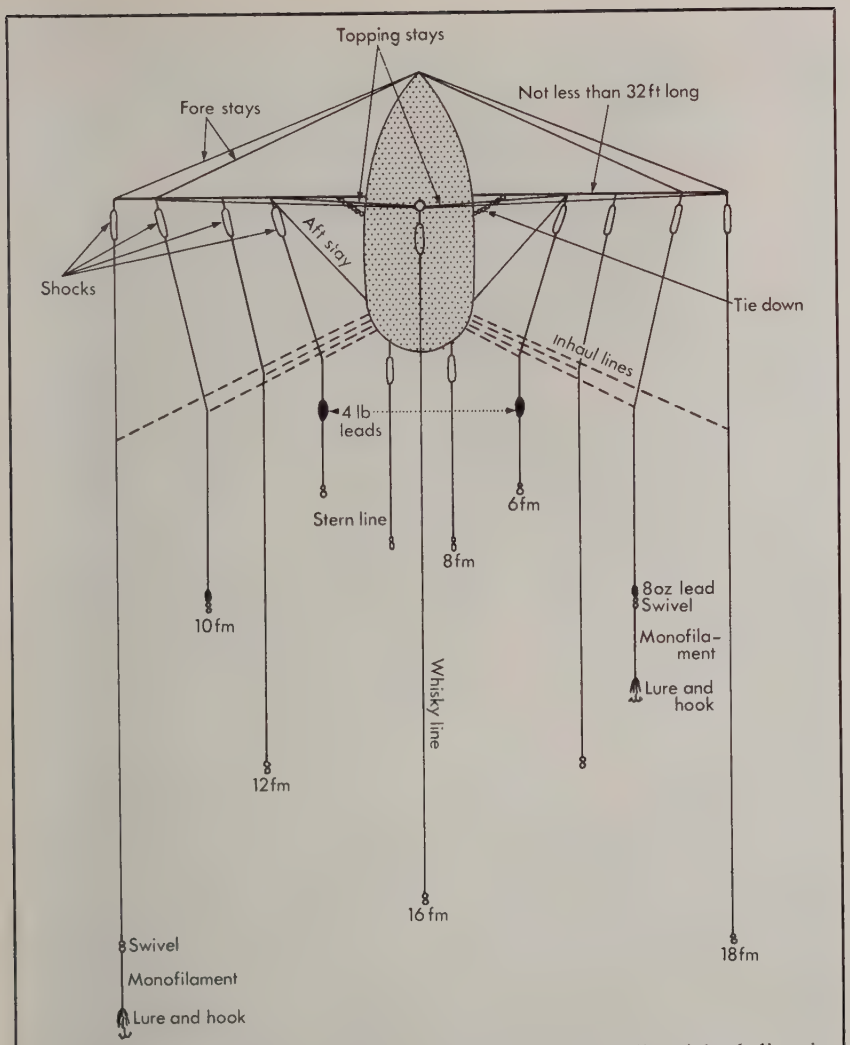

Fore stays
Not less than 25 ft long
Aft stay
Shocks
Tie down
In haul lines
8 oz leads
Whisky line
6 fm
8 fm
12 fm
14 fm
16 fm
Swivel
On all lines
Monofilament
Lure and hook
• Lead weights necessary only to prevent tangles.
• 3 in. diameter poles recommended.
• Position of main lines should be adjusted so that lures fish in the wake.
• Lead weights attached to tag lines forward of the two-pole swivel will keep lines straight while towing in strong winds.

Fig. 16: Trolling rig for vessels between 35 and 45 ft long.



- Inhaul lines must be attached to vessel in correct sequence to prevent tangles. In this rig inhaul line from tip line passes over other lines and is attached forward of other inhaul lines.
- The 12 fathom line inhaul line is attached immediately aft of the tip line inhaul line. The inhaul line of the 10 fathom weighted line passes under the 12 fathom line.

Fig. 17: Trolling rig for vessels over 45 ft long.

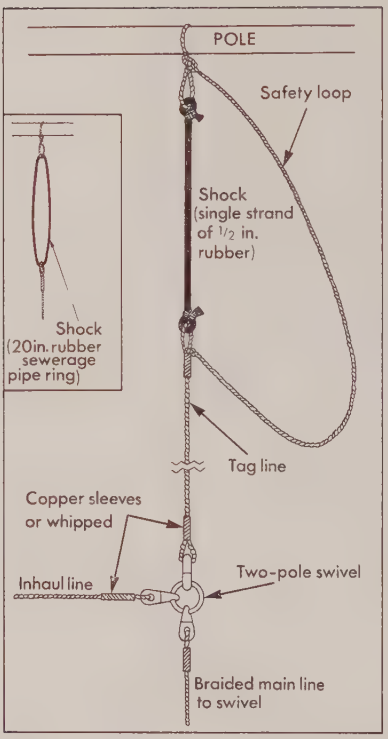


Fig. 18: Methods of attachment of tag, main, and inhaul lines. A safety loop has to bo included as shown when a single strip of rubber is used as the shock.

breaking strain. It is attached to the tag line through a two-pole swivel. The trace is attached to the end of the main line through a barrel swivel and easy release clip (Fig. 19).

The **two-pole swivel** (Figs. 18 and 19) consists of three barrel swivels attached to a uniting ring. It was developed in the pole and live-bait fishery to allow two poles, each held by a fisherman, to be attached to a single fishing trace. In trolling it is used to join tag, inhaul, and main lines. When the inhaul line is pulled in, the ring of the two-pole swivel is slipped over a hook in the gunwale so that tension is kept on the tag line to stop it slipping back into the water and tangling other lines. The hook is bent so that the ring slips off easily when the main line is released.

The **trace** (Fig. 19) is a short length of 200 to 300 lb breaking strain monofilament nylon into which small brass rings and grommets are spliced at each end by small copper or aluminium sleeves (crimps). Lead sleeves can be used, but they do not hold the nylon so well. When fishing is slow a long trace (18 ft) can be used so that the lure is distant from any turbulence that might be made by the swivel. As the nylon cuts into the fingers, a shorter trace (6 ft long) is used when fish are biting well.

Fig. 19: Fishing gear. A: "Arco" → hook. B: "Garwood" hook. C: "Killwell" lure. D: Ruby-eye lure. E: Ruby-eye lure complete with trace. F: "Hexhead" lure. G: Pig-tail easy release clip. H: Two-pole swivel. I: 2 lb lead weight. J: 8 oz lead weight.

Lures. Ruby-eye lures (Fig. 19) have been used successfully by commercial vessels over the last 3 years. These lures consist of a chrome-plated metal head about 1 in. long and weighing 1½ oz and an artificial red glass eye in each side of the head.

A
B
C
D
E
F
G
H
I
J

Monofilament nylon is passed through a hole in the metal head before being spliced on to the ring and grommet; the hook is attached by slipping it through the ring. At the rear of the head is a small neck around which is tied a bundle of about 30 short white feathers and three green or red feathers about 3 in. long.

Other lures (Fig. 19) have been used, and one new American lure, the "Hexhead", consisting of a stainless steel six-sided head and two trailing skirts of phosphorescent green (or red) and white plastic tentacles, has proved to be exceptionally good.

The **hook** is a stainless-steel double-pronged barbless hook attached to the end ring. "Garwood" and "Arco" albacore hooks (Fig. 19) have been used by the New Plymouth fishing fleet.

Outriggers are made of a wood such as kauri or of aluminium tubing. Smaller vessels find that 2 or 3 in. diameter aluminium tubing is suitable, but larger vessels with longer outriggers require 4 in. diameter tubing.

Pole lines are arranged on the outriggers as shown in Figs. 15 to 17. The outermost lines are called tip lines.

Stern lines (Fig. 15) are short lines attached to the stern.

The **whisky line** (Figs. 16 and 17) is a single long fishing line used on larger vessels and is made fast high on a stern mast so that it fishes in the centre of the other lines. It is usually the longest line on the vessel, but some fishermen have shortened it to fish between the stern lines and have made excellent catches from this position. It derives its name from the crew's hope that fish caught on it will pay for their whisky (or beer in New Zealand).

Lead weights (Fig. 19) are sometimes attached to some lines so that they fish at different depths. This method also prevents tangling when a tuna strikes and the line is pulled in. The leads are shaped to travel easily through the water without throwing up a turbulence which might frighten fish from the lure. Care is required with leads. If a fish stretches the line and breaks it at the trace, the shock will be sufficient to throw the lead back at the boat at a high speed.

Trolling gurdies: Power gurdies are used for hauling albacore on some Californian vessels, especially those boats also used for salmon trolling. Gurdies could be introduced by experienced albacore fishermen confident that the decreased labour would warrant the cost.

Boat handling: The recommended trolling speed for albacore fishing is 6 knots and for skipjack is 7 or 8 knots. Once a school has been found, the vessel should be kept on a straight course until no more strikes are made. It should then return on the opposite course to relocate the school, which can be marked with a floating object such as a box or carton. If the school is visible at the surface, it

may be better to fish in a wide circle around it.

Maintenance of Gear

Traces have to be checked regularly and replaced when they are worn. Damage to the trace will occur where the nylon passes through the head of the lure, and this hole should be smoothed before the trace is inserted.

Hooks should be kept greased when they are not in use. This prevents rust from marking the lures. Hooks should be sharpened when necessary and realigned when they are bent.

The lures should be washed in fresh water at night and stored in a clean, dry place. Oil stains will spoil their efficiency. Some fishermen think that all lures used at any one time should be as similar as possible in colour and wear. If one particular lure seems to attract more tuna than other lures, it should be replaced or all the fish will be pulled in on the one line.

During fishing all lures should be checked regularly for weed or debris, as they will not be effective when carrying such materials.

A set of feather lures needs replacing after about 2 tons of fish have been caught. Worn lures can be kept and either remade with new feathers or used again with other lures of about equal wear.

Approximate Cost of Rigging a Vessel Less than 35 ft Long

The cost of rigging a small vessel would be about $97 as listed below (1972 prices). Only the last five items need replacing each season.

	$
Outriggers, two 2 in. aluminium, 17 gauge, each 16 ft	14
Pulleys (2)	2
Brackets (2)	5
Engineering	10
Shocks (6)	2
Lines	12
Two-pole swivels (4)	5
Swivels and easy release clips (6)	5
Nylon	4
Lures (40)	24
Hooks (20)	8
Rings and grommets (20)	4
"Nirco" sleeves (50)	2
	—
	97

The costs for a vessel of 35 to 45 ft and for one over 45 ft long would be about $140 and $180 respectively.

Finding Tuna

INSTRUMENTS available to assist in the finding of tuna schools include acoustic gear (used for finding the tuna themselves or for finding bait-fish) and various types of thermometers (used for finding areas where the surface temperature is suitable for tuna fishing).

Acoustic Gear

Sonar has been of the greatest importance in the finding of pelagic fish, particularly when they are not at the surface. The latest sets are reported as being able to detect schools at a range of 2,500 metres, though this is possible only in open ocean fishing, where reflections from the sea bed do not overshadow the fish echoes. Much experience is needed in interpreting sonar displays; the sets are expensive and are little used at present by New Zealand fishermen.

Echo sounders are used on most vessels, but as they pick up echoes from fish schools only directly beneath a boat, the area able to be scanned is very limited. Interpretation of the echo signals on the chart of the display unit is difficult. One species of fish will give different pictures on different sets, and its picture on the same set will vary according to sea conditions, speed of boat, etc. Moreover different species of fish can give very similar echoes. Only considerable experience and local knowledge will establish whether a certain pattern

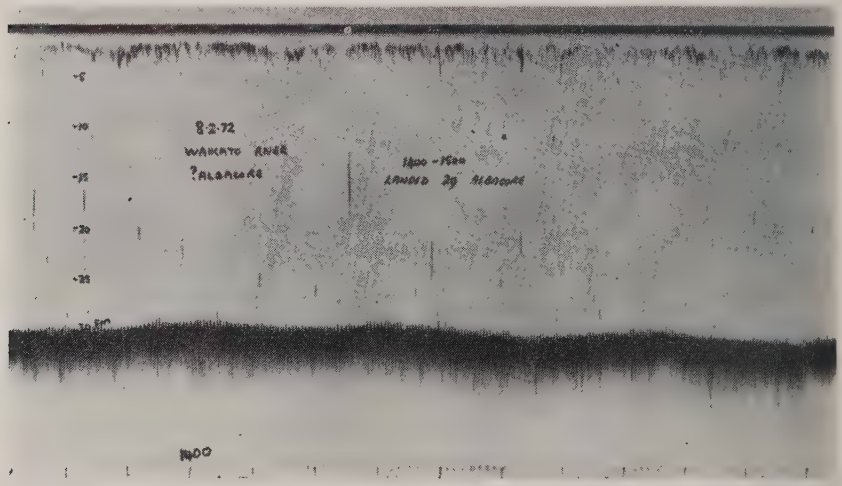


Fig. 20: Echo sounder trace of small fish (thought to be small anchovies) made while albacore were being caught off the Waikato River mouth on 8 February 1972. This was recorded on m.v. *Ikatere* with an "Elac" (30 kHz frequency) sounder at sensitivity 7.

on a given fishing ground indicates a particular species of fish.

Tuna generally give poor echoes, so that most of the pelagic fish picked up on the echo sounder will be bait-fish such as anchovies or pilchards or larger pelagic fish such as kahawai, barracouta, trevally, or mackerel. Good traces of bait-fish do not necessarily mean that tuna will be present, but as tuna feed on them, their presence is always a good sign.

An echo sounding from off the Waikato River mouth during February 1972, which is shown in Fig. 20, illustrates a typical trace when good catches of albacore were being made by trolling. The trace between the surface and 5 fathoms is probably of small anchovy, as the albacore were feeding mainly on this species. Detecting tuna themselves from the echo traces is a somewhat academic exercise. If tuna are showing up on the echo sounder, the operator will be too busy unhooking fish to bother with the trace.

In addition to the use of sound waves for echo ranging it has been suggested that the sounds made by tuna and associated animals can be used to detect and attract tuna, and investigations of this are being made by A. G. York, fisheries technical officer, Ministry of Agriculture and Fisheries.

Temperature Recorders

The occurrence and behaviour of tuna vary from year to year. Research so far indicates that there is a close connection between sea water conditions—their temperature and salinity—and the distribution of tuna. The ranges of sea surface temperature in the areas where most tuna have been caught in New Zealand coastal waters are given in the section on identification. Suitable methods for recording tempera-

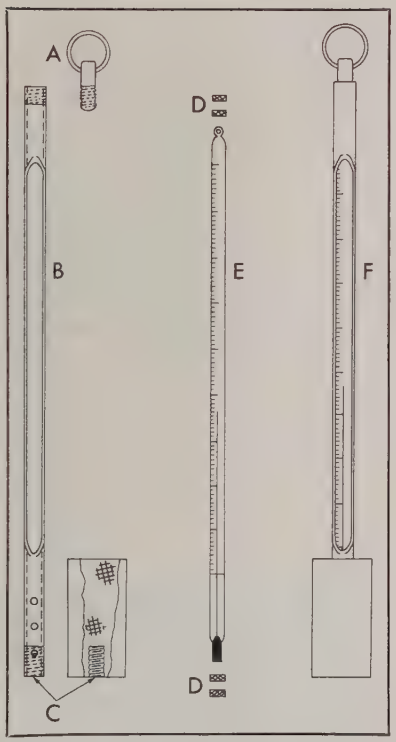


Fig. 21: Mercury thermometer. A: Holding ring and plug. B: Thermometer case. C: Reservoir screws on to thermometer case. D: Sponge rubber pads. E: Thermometer graduated from -5° C to 50° C in 0.1° C intervals. F: Thermometer assembled.

ture are use of a simple mercury thermometer, a probe thermometer, a continuous temperature recorder, or aerial infra-red radiometry.

If a mercury thermometer is used, it should be encased in a metal tube (Fig. 21) and protected against shock by small sponge rubber pads inserted at both ends of the protective guard. A small container should be screwed on to the bottom of the guard to act as a reservoir when the thermometer is removed from the water for reading. The guard and reservoir are made of brass electroplated with chrome.

The probe thermometer (Fig. 22) consists of a long, thin, pointed stainless-steel tube containing a bimetal strip sensitive to temperature changes. The tube is connected to a dial showing the temperature reading. It has the advantage of being much more robust than a mercury-in-glass thermometer and is much more easily read. A further advantage is that it can be used for measuring the core temperature of fish in the catch to check for effective cooling.

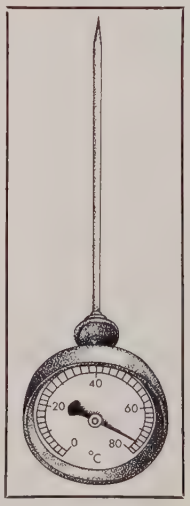


Fig. 22: Probe thermometer.

To take the water temperature rinse a bucket thoroughly in sea water and then refill it. Immerse the thermometer for about a minute, stirring the water gently. If a mercury thermometer is used, read it by lifting the thermometer to eye level. Do this quickly to avoid errors due to atmospheric heating. Take the sample from beneath the surface and away from the outlet of the engine cooling water.

The continuous recording thermometer consists of a sensing element attached in the inlet pipe for engine cooling water or in a special unit clamped to the side of the hull and connected to a recording head similar to that of an echo sounder. A continuous record of the sea temperature at the site of measurement is permanently traced on a strip chart. The sensor cannot be sited on the cooling system if either keel cooling or air cooling is used. As it is a recording device, it does not have to be watched continuously, but can be referred to at suitable intervals. Temperature fronts show up as peaks and depressions on the recorded line (Fig. 23). Many good catches of albacore in New Zealand have been made in highly localised patches showing distinct temperature "fronts" (sharp discontinuities in sea surface temperature).

The sea surface temperature of a large area of water can be measured in a short time with an infra-red radiometer. This instrument works on the principle that, within a certain range of wavelengths, the

amount of infra-red radiation emitted from the sea is proportional to the surface temperature. It can be used at any distance from the object and can be mounted in an aircraft flown at a height of 1,000 ft at 120 knots. The purpose of this instrument is to prepare isotherm maps for finding areas in which the sea surface temperatures indicate that tuna are most likely to be present. It is also used to find temperature fronts.

Isotherm maps look like contour maps (Fig. 24), and fronts are shown where the isotherms on the map are close together. The information collected by this method must be processed at an operations centre and the information passed on to the fishing fleet. Sea surface temperatures are constantly changing and sea areas will need to be surveyed at regular intervals during the fishing season and the information sent to fishermen as soon as possible after collection.

Aerial Spotting

Aerial spotting enables an extensive area to be surveyed quickly for tuna and boats to be directed into promising localities or on to schools of tuna. For instance, in February 1970 good albacore fishing was obtained over a period of 3 days near Oakura, south of New Plymouth. On the fourth day the fish had disappeared. Aerial spotting showed that the schools had moved

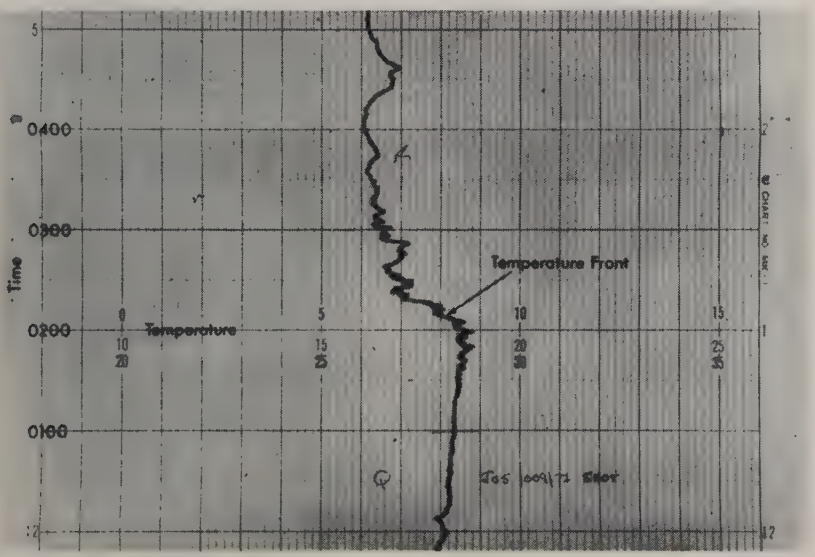


Fig. 23: Continuous temperature recorder trace made off Cape Turnagain on 27 March 1972 on m.v. *James Cook* with a "Murayama" electric resistance thermorecorder on the 8-26° C scale.

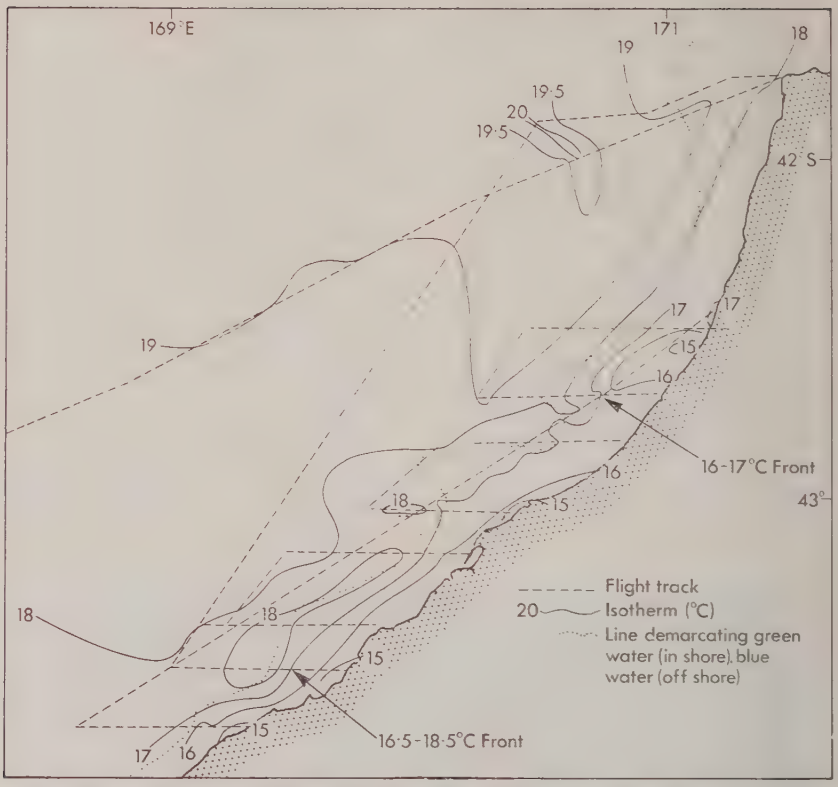


Fig. 24: Isotherm map made on the west coast of the South Island, 21 to 22 March 1972 from a Piper Aztec aircraft flying at about 1,000 ft at 120 knots.

northward, and catches were made again off the Mokau River, north of New Plymouth.

Detection, and identification, of schools is largely a matter of experience. Through directing boats on to schools showing various characteristics and being informed by radio telephone of the catches made, a spotter learns to correlate displays of a flock of sea birds and fish schools with fish species. Conditions may vary between fishing grounds, and it is better for a spotter to develop his own system of observation than rely on advice based on observations in other areas. It seems to have been generally agreed among various spotters that birds which are light coloured (such as gulls and terns) are usually associated with kahawai, barracouta, and mackerel, and darker birds (petrels and shearwaters) usually feed in association with

tuna. Gannets, however, which are predominantly white, often dive near tuna schools.

Some schools are unaccompanied by birds and in these fish size and colour, as well as the behaviour of the schools and individual fish in a school, are useful guides. Identification of fish schools cannot be discussed further here, as insufficient information has been collected in the New Zealand region.

Spotting from the Boat

The area which can be scanned from a boat is very limited, and though a big tuna clipper may carry a lookout in the crow's nest, spotting on a smaller boat will probably be from deck level. Consequently, fish schools will seldom be seen unless they are accompanied by birds.

Though terns and gulls are unlikely to lead to tuna schools, tuna can sometimes be taken with kahawai and barracouta from under a flock of gulls and terns; so it is always worth investigating any flock of feeding birds. The fisherman should be able to recognise the more important birds. He must realise that some birds follow boats for a free meal rather than look for fish themselves and it is unlikely that these species will lead a boat to tuna. (For example, many species of albatross and mollymawk as well as the giant petrel (or nelly) and gulls follow boats.)

The following birds can indicate the presence of tuna:

Fig. 25: Fleshfooted shearwater.

Fleshfooted shearwater (Fig. 25): A large all-brown shearwater with a pale beak, darker at the tip, and pale flesh-coloured feet. These birds often follow boats, but sometimes feed in small flocks over tuna.

Buller's shearwater (Fig. 26): Also a large shearwater with a black head cap and neck shading to grey on the back and on the upper wing. There is a distinct black W across the wings and back. The underparts are pure white. It rarely follows boats and is often seen in small flocks near tuna schools.

Sooty shearwater (muttonbird) (Fig. 27): Another large brown shearwater with greyish underparts

Fig. 26: Buller's shearwater.

and a few white underwing feathers which show as a flash of white when the underwing is visible. Sooty shearwaters gather in large flocks in southern New Zealand waters near the main breeding grounds around Stewart Island. They also occur in smaller numbers throughout New Zealand coastal waters and are sometimes associated with tuna schools. They rarely follow boats.

Fluttering shearwater (Fig. 28): A small shearwater, brown above and mostly white below. It has a distinct rapid wing beat with occasional short gliding motions, which, together with the smaller size, make it easy to distinguish from the larger shearwaters, which have a less energetic rising and falling gliding flight. Large flocks of these birds are often seen feeding over tuna schools. Fluttering shearwaters do not follow boats.

Fairy prion (whalebird) (Fig. 29): A very small grey-blue bird, slightly darker above than below with a prominent black W across the wings and back and with blackish patches behind and below the eye. These birds never follow boats and sometimes occur in large flocks both near their breeding grounds and off shore. They are not noted to be

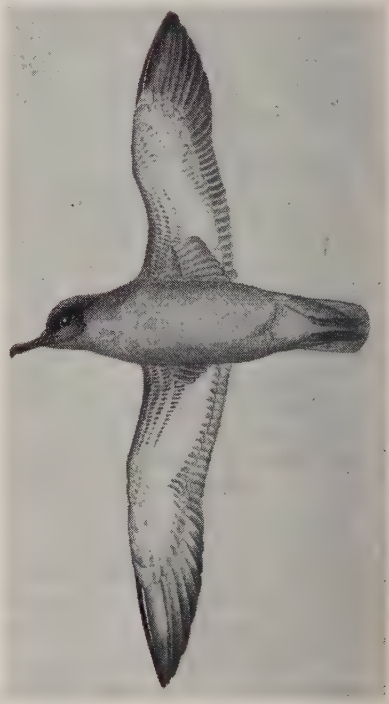


Fig. 27: Sooty shearwater.

good indicators of tuna schools, but are always worth chasing if fish are not being caught.

White-faced storm petrel (Jesus Christ or J. C. bird) (Fig. 30): Slightly smaller than prions. Crown, nape, and patch below eye smoky greyish brown, brown above, white below, and with black on the top of the tail. The bill and feet are black, and the feet trail below the bird, which appears to walk on or skip across the water. White-faced storm petrels are more common off the north-east coast of New Zealand. They rarely form closely associated flocks, but large numbers are often seen in a restricted area.

Fig. 28: Fluttering shearwater.

Fig. 29: Fairy prion.

Water Colours

Tuna usually occur in areas where the water is a clear blue. During summer they move in shore and are sometimes found where river or coastal run-off water meets oceanic water, the former being green and the latter blue. A blue-green boundary is worth following, as a strike of tuna will usually be met somewhere along it during the fishing season. Monitoring for temperature is still advisable, as the water must be within the right temperature range for the tuna.

Fish Schools

Bait-fish include anchovy, pilchard, sprat, mackerel, young kahawai, and many other species and are always a good sign of the

Fig. 30: White-faced storm petrel.

possible presence of tuna. When the water is calm, particularly at dusk or dawn, schools of bait-fish frequently come to the surface, where they have the appearance of "cats-paws" of wind. Such bait schools are called "breezers" by Americans.

Later in the day these schools of bait-fish tend to submerge and can often be seen as dense spherical shadows at about the limiting depth of vision. These are called "meat-balls." The tendency of the fish to "ball up" in this way is usually a sign that they have been attacked by predators, including dolphins and tuna. Sometimes there is an oil slick visible where tuna have fed on a school of bait-fish. Meat-balls are also a very good source of live bait for pole fishing and can be readily taken with a small purse seine or lampara.

If albacore or yellowfin are feeding in the same area as dolphins, it is profitable to fish where dolphins are jumping. However, few high catches have been made in New Zealand coastal waters when dolphins were around the vessel.

Fisherman's Logbook

Fishermen who take up tuna trolling are strongly advised to develop the habit of keeping the following information in a notebook on every trip:

- Date.
- Fishing grounds.
- Weather.
- Sea surface temperatures.
- Catch of each species.
- Observations on association of tuna with birds, dolphins, water colour, etc.

These notes will ultimately provide knowledge of seasonal variations in the yields from their fishing grounds, and by relating catch rates to weather and to sea temperatures fishermen should be able to understand better the causes of changes in the location of fishing grounds.

Handling the Fish

"TUNA can bruise, sweat, and split if handled harshly. They can gore each other in a fish room; belly walls can be eaten away by enzymes; they can be rancid (sour) but still of good physical appearance, shape, and texture; and they can be soft, slimy, putrid, with terribly offensive odours. The flesh can be grey and soggy . . ." (Brian A. Hurrell, South Australian Fisheries Co-operative, Port Lincoln.)

Correct and careful handling of the catch is essential. Initially, much of the New Zealand tuna catch will be exported whole and frozen and the standards of inspection and general rules regarding frozen tuna required by the receiving market must be strictly observed.

Keeping fish aboard in good condition is not difficult, but continual vigilance is demanded from the fishing master. Tuna quality becomes substandard after 8 to 9 days at 0° C, 3 to 4 days at 2.2° C, and 2 days at 4.4° C. Four methods of handling tuna that are suitable for trolling vessels are salt water chilling, freezing, icing, and carriage as deck fish.

Salt Water Chilling

Salt water chilling (Fig. 31) is an ideal method for vessels over 40 ft long. Fish can be immersed immediately on coming aboard and so leave the decks clear. The fish are kept clean and are instantly killed, which reduces damage caused by their beating on the deck. Sea water is cooled in a chilling tank and circulated through a fish-holding tank, which should be mounted aft for convenience. About 50 cu ft of salt water is needed for each ton of fish. Usually two fish tanks are mounted on the deck, one for holding bait and one for tuna. The bait tank can be converted to a fish-holding tank when required. The

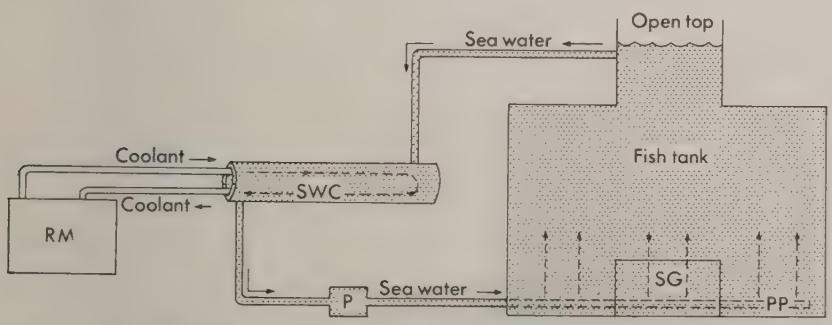


Fig. 31: Salt water chiller. SWC: Sea water chiller. RM: Refrigeration module. SG: Sliding gate. PP: Perforated pipe for circulation through fish tank (between fish). P: Pump.

temperature must be kept above —1.1° C to prevent freezing of water in the chiller.

Tanks used by some rock lobster fishermen for bringing live fish into port would be quite suitable for conversion to salt water chillers.

Freezing

Blast freezing is another good method for keeping tuna in good condition, but usually only small quantities can be successfully frozen. Attempts to freeze large quantities simultaneously will result in sub-standard fish.

Icing

This method is suitable for trips not exceeding 4 or 5 days. Fish should be stacked less than 3 ft deep in an insulated container or fish hold. A 3 in. layer of ice should be placed on the floor and alternate layers of tuna and ice above this, with at least one part of ice to three parts of tuna. Skipjack are softer fish and should be placed on top of albacore rather than beneath them. Ice is far cheaper than tuna and it is better to carry too much ice than to bring in poor-quality fish.

Deck Fish

Fish should not be carried on the deck unless the boat is close to port. Any fish carried on deck should be shaded from the sun, and to do this a large canvas awning is needed. The canvas, but not the tuna, should be sprayed with sea water to keep it cool and there should be a gap for air circulation between the awning and the fish. Periodic spraying of tuna will result in more rapid deterioration from increased humidity.

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